

Subject Index

a

- A8 isomers 272
- above stage convention 64
- absorbers
 - atmospheric distillation unit 85
 - fluid catalytic cracking 145, 167, 182
 - vacuum distillation unit 129 ff
- acentric factor 34, 43, 46, 54, 395
- acid functions 261
- acid number 5
- acid site reaction 372
- acid-catalyzed cracking 151
- activity factors 43
 - continuous catalyst regeneration reforming 341
 - fluid catalytic cracking 214, 222, 227
 - hydrocracking 383, 386, 435, 444–451
 - hydroprocessing units 372
- adjustment factors 84, 284
- adsorption 266, 271
- alkylation 147
- alkylcycloalkanes 260
- alkylcyclopentanes 260
- alumina-based catalysts 260
- amines 369, 381
- aniline point 5
- API (American Petroleum Institute)
 - correlations
 - atmospheric distillation unit 81
 - continuous catalyst regeneration reforming 277
 - fluid catalytic cracking 173
 - hydroprocessing units 370
- API gravity *see* gravity
- API standards 40, 48 f
- API true boiling points 91
- apparent cracking heat 222
- aqueous phase 108
- Arab properties 66, 71 f
- aromatic hydrogenation 425
- aromatic ring condensation 146, 151 f
- aromatics 6
 - CatReform model 274
 - continuous catalyst regeneration reforming 253 f, 259–263, 280–300, 350, 356
 - fluid catalytic cracking 151–163, 171, 198, 211
 - hydroprocessing units 369 ff
- Arrhenius equation 390
- Aspen HYSYS 48
 - atmospheric distillation unit 58–84
 - continuous catalyst regeneration reforming 312
 - main fractionator 230
 - molecular weight 33 ff
 - oil fractions 8
 - vacuum distillation unit 124–130
- Aspen HYSYS Petroleum Refining
 - Catalytic Reformer Model 253, 270, 276
 - deep-cut operation 139
 - fluid catalytic cracking 145 ff, 159 ff, 200
 - hydrocracking 363–369, 457
 - oil fraction duplication 21
- Aspen PIMS planning software 191, 195, 241, 246, 430
- Aspen RefSYS
 - continuous catalyst regeneration 312
 - fluid catalytic cracking 200
 - HCR model 438, 456
- assays
 - oil fractions 24
 - atmospheric distillation unit 66
- ASTM (American Society for Testing and Materials) distillation
 - continuous catalyst regeneration reforming 253, 259
 - D-1160 fluid catalytic cracking 173

Refinery Engineering: Integrated Process Modeling and Optimization, First Edition.

A.-F. Chang, K. Pashikanti, and Y. A. Liu

© 2012 Wiley-VCH Verlag GmbH & Co. KGaA. Published 2012 by Wiley-VCH Verlag GmbH & Co. KGaA.

- D-1160 vacuum distillation unit 124, 129 ff, 134
 - D-86 atmospheric distillation column 92
 - D-86 fluid catalytic cracking 178
 - hydrocracking 393
 - hydroprocessing units 370
 - oil fractions 6 ff, 13 ff, 48 f
 - ATM-100 column environment 107
 - atmospheric crude distillation section 89
 - atmospheric distillation unit (ADU) 57–117
 - oil fractions 7
 - atmospheric gas oil (AGO) 62
 - atmospheric residue 119 ff, 136
 - average absolute deviation (AAD)
 - continuous catalyst regeneration reforming 288 f
 - fluid catalytic cracking 169, 175, 180 f
 - HP hydrocracking 415, 419
 - MP hydrocracking 403
 - average relative deviation (ARD) 403, 415
 - average voidage 161
- b**
- back-blending
 - atmospheric distillation column 58, 68, 90, 98, 109
 - crude distillation column 104
 - fluid catalytic cracking 166, 174
 - vacuum distillation unit 120
 - backward feedstock approach 369 ff
 - base hydrocracking data set 379
 - base vector 191
 - basic FCC model 204
 - basic reformer configuration 316
 - basis environment 29
 - Benedict–Webb–Rubin–Starling (BWRS) 46
 - benzene 253, 284, 290, 300
 - benzothiophene 369
 - beta density function
 - atmospheric distillation unit 68
 - continuous catalyst regeneration reforming 276 ff
 - fluid catalytic cracking 168 f, 173 f
 - oil fractions 10, 15
 - bifunctional/bimetallic catalysts 260
 - blending
 - atmospheric distillation unit 77, 102
 - continuous catalyst regeneration reforming 330
 - fluid catalytic cracking 190
 - oil fractions 27
 - boiling points 51 *see also* true boiling points
 - atmospheric distillation unit 66
 - fluid catalytic cracking 153, 162, 170 ff
 - hydrocarbons 34, 39 f, 393
 - hydrocracking 399, 411 ff
 - oil fractions 5, 8 ff, 39
 - vacuum distillation unit 121
 - Bolkan-Kenny correlation 161
 - bottom oil 407–414, 427 f
 - Braun-K10 (BK-10) correlation 44, 81
 - bromine number 370
 - BTEX (benzene, toluene, ethylbenzene, xylenes) 253, 258
 - BTX production 272 ff, 300 ff
 - bubbling bed reactor 159
 - bulk properties 52
 - atmospheric distillation unit 66, 75 ff
 - continuous catalyst regeneration reforming 321, 331, 267, 276
 - fluid catalytic cracking 145, 210
 - hydroprocessing units 371
 - light naphtha 100
 - oil fractions 4, 25
 - vacuum distillation unit 126
 - butane 147, 244, 291, 307
 - butenes 244
- c**
- calculation of MeABP 18
 - calibration
 - continuous catalyst regeneration reforming 253, 280 ff, 318, 332–343
 - fluid catalytic cracking 164, 174, 208, 222, 227 ff
 - hydrocracking 384, 387, 440–456
 - carbocation 151
 - catalysts
 - continuous catalyst regeneration reforming 253 ff, 318, 323
 - fluid catalytic cracking 147, 159, 163, 200, 211 f
 - HP hydrocracking 425
 - hydrocracking 387, 434, 438
 - MP hydrocracking 403
 - catalysts deactivation *see* deactivation
 - catalyst-to-oil ratio 158, 184, 187
 - catalytic cracking 151, 190
 - catalytic reforming 30
 - CatReform model 254, 270 f
 - C–C scission 372
 - cetane number/index 7
 - Chao–Seader method 45
 - characterization of oil fractions 1–56
 - chemical feedstock production 301
 - chemical type lumps 153
 - chromatographic simulation 7
 - Chueh–Praudnitz correlation 38

- cloud point 5, 48, 198, 226
- coke
 - catalyst deactivation 163
 - continuous catalyst regeneration reforming 295
 - fluid catalytic cracking 147–158, 186, 192, 244
 - HP hydrocracking 425
 - vacuum distillation unit 137
- coker gas oil (CGO) 147
- columns
 - atmospheric distillation unit 60–70, 84–94, 106, 112
 - continuous catalyst regeneration reforming 274, 292, 347 ff
 - fluid catalytic cracking 145, 230
 - hydrocracking 399, 405
 - vacuum distillation unit 119, 124, 135
- combustion heat 5
- component list
 - blends 103
 - continuous catalyst regeneration reforming 312
 - fluid catalytic cracking 201
 - hydrocracking 470
 - vacuum distillation unit 127
- components (hypothetical) 66
- composition
 - continuous catalyst regeneration reforming 268, 276
 - fluid catalytic cracking 199
 - hydroprocessing units 369
 - light components 26
 - LPG-HP HCR 421
- computational fluid dynamics (CFD) 158
- computer files 479 ff
- condenser 63, 90 f, 112, 146
- configuration
 - atmospheric distillation column 61, 84, 88, 107 ff
 - continuous catalyst regeneration reforming 258, 311, 345 ff
 - DA301 348
 - fluid catalytic cracking 147, 159, 205–214
 - hydroprocessing units 383, 429
 - reformer 316 ff
 - refractionator 230
 - vacuum distillation unit 124, 128
- Conradson carbon (concarbon / CON) 194, 242
- Conradson carbon residue 5, 158, 175, 210 f
- contaminants 137
- continuous catalyst regeneration (CCR) reforming 253–362
- continuously stirred-tank reactor (CSTR) 159
- control window 319
- convergence
 - atmospheric distillation column 84–90
 - continuous catalyst regeneration reforming 321, 326
 - fractionation 166, 217, 228, 232, 274
 - hydrocracking 438, 443
 - hydroprocessing 384, 438, 443
 - solver 217, 324, 342
 - vacuum distillation unit 124, 132
- conversion (distillation curves) 7 ff, 388
see also ASTM, API
- correlations 79 ff
 - API 81, 173, 277, 370
 - Bolkan-Kenny 161
 - Braun-K10 (BK-10) 44, 81
 - Chueh-Prausnitz 38
 - ESSO 81
 - Goosen 173
 - Grayson–Streed 45, 81
 - Lee-Kesler 52
 - Riazi's 274
 - Riazi-Daubert 51 f, 170, 173, 395 ff
 - Riedel 41
 - Twu 32
- COSTALD (Corresponding States Liquid Density) correction 37, 47, 53
 - atmospheric distillation column 95
 - continuous catalyst regeneration reforming 314
- cracking *see also*
 - acid-catalyzed ~, catalytic ~, thermal ~, over~, high-pressure hydro~, fluid catalytic ~, hydrocracking
 - atmospheric residue 123
 - fluid catalytic cracking 146, 151 f
- creep step parameters 217, 324, 443
- critical pressure 43, 54 *see also* pressure
- critical properties 34
- critical temperature 43 *see also* temperature
- crude assays
 - atmospheric distillation unit 66, 101
 - oil fractions 1 ff, 90
- crude charge 81
- crude distillation unit (CDU) 57, 84, 110–115
 - hydrocracking 364, 383, 399
 - MP hydrocracking 376, 379
- crude feed 31, 66
 - atmospheric distillation column 75–104
 - fluid catalytic cracking 145, 168 ff, 190–195
 - vacuum distillation unit 117, 135
- crude fractionation 42, 53, 65 f

- crude furnace 58, 81
- crude oil 1, 120, 135, 138
- crude tower 68, 231
- cubic equation of state 46
- cubic-average boiling point (CABP) 9
- current FCC simulation 222
- cut points
 - heavy vacuum gas oil 117
 - hydrocracking 396
 - oil fractions 27
 - vacuum distillation unit 126, 135 f
- cycle oil 147 f, 224, 230, 244
- cyclization
 - CCR reforming 255
 - fluid catalytic cracking 147
- cycloalkanes 151 f
- cycloheptane 262
- cyclohexanes 260
- cyclones 159

- d**
- D-1160 distillation curve 168, 393
- D-86 distillation curve 145, 277
 - see also* ASTM –, API –
- data
 - atmospheric distillation unit 66
 - continuous catalyst regeneration reforming 280
 - hydrocracking 379
 - vacuum distillation unit 119, 139
- deactivation *see also* catalysts
 - CatReform model 271
 - continuous catalyst regeneration reforming 253
 - fluid catalytic cracking 164
 - hydrocracking 438
- dealkylation 146, 151 f
- debutanizer
 - continuous catalyst regeneration reforming 275
 - fluid catalytic cracking 145, 183, 230
 - hydrocracking 399
- decyclization 147
- de-emulsification agents 60
- deep-cut operation 117, 135, 139 ff
- default calibration parameters 208
- deheptanizer 275
- dehydrocyclization 257, 263
- dehydrogenation
 - CatReform model 271
 - continuous catalyst regeneration reforming 257–266, 284, 293, 341
 - fluid catalytic cracking 146–151 f
- dehydroisomerization 260
- delta-base vectors
 - continuous catalyst regeneration reforming 305, 308
 - fluid catalytic cracking 145, 192, 246
 - HP hydrocracking 429
 - linear-programming-based production 240
- delumping method
 - fluid catalytic cracking 160
 - Gaussian–Legendre Quadrature 399
 - hydrocracking 399, 433
- density 52
 - atmospheric distillation unit 66, 71, 75 ff, 91–95
 - continuous catalyst regeneration reforming 276
 - fluid catalytic cracking 168–179
 - hydrocarbons 39
 - hydrocracking 394
 - pseudocomponents 8, 39
- depetanizer 258
- desalting 59
- desorption 371
- dewatering 59
- dibenzothiophene 369
- diesel
 - atmospheric distillation unit 66
 - fluid catalytic cracking 170 f, 178, 192, 224
 - HP hydrocracking 428
 - hydrocracking 384, 400
 - hydroprocessing units 363
 - MP hydrocracking 376, 407 ff
 - paraffin/aromatic content 51
- DIPPR (Design Institute for Physical Property Research, American) 31
- dirty-water approach 42
- distillation column
 - atmospheric distillation unit 91
 - hydrocracking 405, 399, 417 f
 - hydroprocessing units 367
 - model development 63
 - vacuum distillation unit 119
- distillation curves 49 ff
 - Aspen HYSYS Oil Manager 100 ff
 - atmospheric distillation column 91
 - continuous catalyst regeneration reforming 253, 268, 276
 - fluid catalytic cracking 168, 175
 - hydrocracking 393, 401 ff, 421
 - interconversion 7 ff
 - liquid HCR products 409
 - oil fractions 25
 - vacuum distillation unit 124 ff
- distillation unit
 - atmospheric 57–116

- fluid catalytic cracking 198
- vacuum 124 ff
- downstream fractionation units 148
 - continuous catalyst regeneration reforming 254, 344
 - fluid catalytic cracking 146
- draw rate 113, 399 f
- dry gas
 - continuous catalyst regeneration reforming 295
 - fluid catalytic cracking 181, 189, 199, 224 f
 - HP hydrocracking 419 f
- duplication 21
- duty specifications (ADU) 86

e

- efficiency factor *see also* Murphree η , stage efficiency
 - atmospheric distillation unit 65
 - continuous catalyst regeneration reforming 274
 - fluid catalytic cracking 165
- effluents
 - continuous catalyst regeneration reforming 255
 - fluid catalytic cracking 219
 - hydrocracking 393, 396, 411, 472
- end boiling point (EBP) 3
- end of run (EOC) 425
- energy consumption 303, 405
- energy flows 34, 42 f, 58
- enthalpy methods 47, 64
- equation-of-state (EOS) 36–53
 - atmospheric distillation unit 81
 - vacuum distillation unit 126
- equilibrium A8 isomers 272
- equilibrium-based approach 63
- equilibrium catalyst properties 200
- equilibrium stages 63, 124
- equivalent HCR reactor 388
- errors
 - atmospheric distillation column 106
 - continuous catalyst regeneration reforming 283
 - fluid catalytic cracking 168
 - hydrocracking 385
- ESSO correlation 81
- ethane 147, 291, 307
- ethylbenzene 253
- ethylene 376
- Excel *see* MS Excel
- Excel spreadsheet interface (ADU) 68
- extrapolation of incomplete distillation curve 15

f

- feed
 - atmospheric distillation unit 58, 66, 105
 - continuous catalyst regeneration reforming 253, 276, 282 f, 287, 310, 335
 - fluid catalytic cracking 145, 158, 168, 175, 192
 - fluid catalytic cracking 208, 214
 - hydrocracking 436, 458
 - vacuum distillation unit 122
- feed flow rate versus product distribution 427
- feed lumping technique 270
- feed oil 366, 380
- feed rate
 - fluid catalytic cracking 188, 233, 236
 - WHSV 303
- feed rate–process yield relation 296
- feed sulfur change 189
- feed type library (fingerprint) 208 f, 211, 216, 436
- feedstock 52
 - continuous catalyst regeneration reforming 259 ff
 - fluid catalytic cracking 145, 162, 189
 - hydrocracking 376, 382
 - hydroprocessing units 369
 - oil fractions 1
 - vacuum distillation unit 117, 126
- feedstock quality–process yield relation 300
- final column convergence 89
- fitting parameters of beta distribution 53
- flash point 44, 49
 - fluid catalytic cracking 145, 175, 180
 - HP hydrocracking 422
 - hydrocracking 384, 402
 - MP hydrocracking 412 f
 - oil fractions 4, 48, 53
- flash zone
 - atmospheric distillation unit 61, 66, 70
 - hydrocracking 399
 - vacuum distillation unit 118, 125, 141 f
- flow diagram
 - Aspen HYSYS Petroleum Refining HCR 367
 - continuous catalyst regeneration reforming 256
 - HP hydrocracking unit 377
 - MP hydrocracking unit 376
 - single-stage HCR process 364
 - vacuum distillation unit 118, 133
- flow rate
 - atmospheric distillation unit 70 ff, 102
 - continuous catalyst regeneration reforming 281, 311, 321

- fluid catalytic cracking 175, 198
 - hydrocracking 380, 388
 - hydroprocessing units 365
 - vacuum distillation unit 119
 - flow specifications
 - atmospheric distillation unit 86, 88
 - hydrocracking 436
 - flowchart
 - Aspen HYSYS 205, 326
 - atmospheric distillation unit 62, 80, 103
 - downstream fractionation 344
 - integrated reformer model 267
 - vacuum distillation unit 129, 133
 - flue gas 147, 99
 - fluid catalytic cracking (FCC) 145–252
 - oil fractions 8, 30
 - vacuum distillation unit 117
 - fluid package 203, 314
 - fluorescent indicator adsorption (FIA) 370
 - forward feedstock compositions 369 ff
 - fractional properties 6
 - fractionation 52
 - atmospheric distillation unit 66
 - CatReform model 273 ff
 - continuous catalyst regeneration reforming 253, 270–288
 - fluid catalytic cracking 165, 175
 - MP hydrocracking 376
 - oil fractions 8, 42
 - vacuum distillation unit 124
 - fractionators
 - fluid catalytic cracking 145, 182, 197, 230
 - HP hydrocracking 417
 - hydrocracking 381, 393, 398
 - hydroprocessing units 363
 - MP hydrocracking 405
 - free-water approach 42
 - freeze point 50
 - HP hydrocracking 422
 - hydrocracking 402
 - MP hydrocracking 412 f
 - oil fractions 4, 48, 53
 - Froude numbers 161
 - fuel gas 224 f
 - fuel properties 48
 - fuel property index 54
 - fugacity coefficient 43 ff, 54
 - fugacity correlation 81
 - fundamental modeling premise 57
- g**
- gas composition 105
 - gas compressor 145
 - gas flowrates 199
 - gas oil 66
 - gas plant 150, 177, 197, 230
 - gas streams 123
 - gas yield 356
 - gasoline
 - continuous catalyst regeneration reforming 254, 300
 - fluid catalytic cracking 147–152, 163, 178–192, 224
 - hydroprocessing units 363
 - production scenarios 233
 - stabilization column 230
 - Gauss–Legendre quadrature 396–402, 433
 - Goosen's correlation 173
 - gravity *see also* specific gravity
 - atmospheric distillation unit 70
 - continuous catalyst regeneration reforming 268
 - fluid catalytic cracking 161
 - HP hydrocracking 429
 - hydrocracking 396
 - hydroprocessing units 370
 - vacuum distillation unit 119
 - Grayson–Streed correlation 45, 81, 92
- h**
- heat balance 222, 229
 - heat capacity
 - CatReform model 273
 - oil fractions 31, 38–42, 53
 - heat exchangers 81
 - heat flow 83, 130
 - heat losses 207
 - heat recovery 60
 - heaters 61, 81 f, 323
 - heavy cycle oil (HCO) 147 f
 - heavy naphtha 86–99 ff, 111 *see also* naphtha
 - heavy straight run naphtha (HSR) 62
 - heavy vacuum gas oil (HVGO) 117, 122, 128, 135 f
 - Hessian parameters 217
 - high heating value (HHV) 5
 - high-pressure hydrocracking (HP HCR) 363–377, 388
 - hot catalyst 147
 - how-to scenario 293
 - hydrocarbon–hydrocarbon interactions 42
 - hydrocarbons 6 ff, 32–41
 - atmospheric distillation unit 66
 - continuous catalyst regeneration reforming 268
 - fluid catalytic cracking 203
 - hydrocracking 396
 - molecular weight 32

- vacuum distillation unit 118
 - hydrocracking (HCR) 363–377
 - CatReform model 271
 - continuous catalyst regeneration reforming 257–266, 284, 293, 301, 341
 - fluid catalytic cracking 147
 - high-pressure 363–377, 388
 - medium-pressure 363, 366, 376, 383
 - oil fractions 30
 - hydrodenitrogenation (HDN) 363
 - hydrocracking 382, 443
 - hydroprocessing units 371, 375
 - MP hydrocracking 403
 - hydrodesulfurization (HDS) 363
 - hydrocracking 382, 443
 - hydroprocessing units 371, 374
 - MP hydrocracking 403
 - hydrogen 147, 307, 356
 - hydrogen balance 281 ff, 376
 - hydrogen consumption 425
 - hydrogen flow rate 404, 416
 - hydrogen partial pressure 425
 - hydrogen recycle system
 - hydrocracking 437
 - HP hydrocracking 415 f
 - hydroprocessing units 369
 - MP hydrocracking 403
 - hydrogen transfer 146, 151 f
 - hydrogen/oil ratios 425
 - hydrogenation 147
 - hydrogenolysis 260
 - hydrogen-to-hydrocarbon ratio 253, 262, 293 ff, 301, 322, 351 ff
 - hydrogen-to-oil ratio vs. product distribution 425
 - hydroprocessing 190, 363–478
 - hydrotreating 363
 - hypothetical components 66, 79
- i**
- ideal gas heat capacity 31, 38, 43, 53 f
 - ignition 49
 - impurities 58
 - increment factor 458
 - index-based approach 49
 - indicators 259
 - inhibitors 371
 - initial assay definition 75
 - initial boiling point (IBP) 5
 - initial columns 70, 84
 - initial components 200, 312
 - initial crude processing 59
 - initial model solution 217
 - initial stream setup 85
- inlet streams 381
 - input feedstock 319
 - inside-out method 65
 - Institute of Chemical Engineers database 41
 - interaction parameter 43
 - interaction parameters
 - continuous catalyst regeneration reforming 315
 - fluid catalytic cracking 204
 - interconversion of distillation curves 7, 13 ff
 - intrinsic rate constant 372
 - isenthalpic/isobaric flashes 44
 - isobutane 307
 - isomerization
 - CatReform model 271
 - continuous catalyst regeneration reforming 257–266, 284, 341
 - fluid catalytic cracking 146–153
 - isoparaffins 260
 - isothermal flashes 44
 - isothermal plug flow reactors 388
 - iteration spreadsheet of MeABP calculation 11
- j**
- Jacobians 194, 305, 430
 - jet fuel 419 ff
- k**
- kerosene
 - atmospheric distillation unit 62, 66, 98
 - D-86 comparison curve 93, 110
 - fluid catalytic cracking 170 f
 - paraffin/aromatic content 51
 - kinetic coke 163
 - kinetic lumping
 - continuous catalyst regeneration reforming 253, 263–267, 331
 - fluid catalytic cracking 153 f, 168, 220
 - hydrocracking 395
 - hydroprocessing units 363, 366
 - kinetic models / networks 263
 - continuous catalyst regeneration reforming 253
 - fluid catalytic cracking 145, 153
 - oil fractions 30
 - kinetic-to-fractionation lumps conversion 173
 - K-value 44 ff, 53
 - atmospheric distillation unit 64, 81
 - continuous catalyst regeneration reforming 268
 - oil fractions 9, 31, 38, 53

I

Langmuir–Hinshelwood–Hougen–Watson (LHHW) mechanism 371
 least squares sum 169
 Lee-Kesler correlations 32–42, 52
 light components 61, 127
 light cycle oil (LCO) 147 f, 224, 230, 244
 light ends tuning 284
 light gas
 – atmospheric distillation unit 78
 – continuous catalyst regeneration reforming 295, 341
 – fluid catalytic cracking 148, 224
 – vacuum distillation unit 123, 127
 light gas oil (LGO)
 – atmospheric distillation unit 62
 – D-86 comparison curve 93 ff, 111
 – draw rate 113 ff
 light naphtha
 – atmospheric distillation column 99 ff, 108
 – D-86 comparison curve 92, 97, 110
 light straight run naphtha (LSR) 62
 Line search parameters 217
 linear programming (LP)
 – continuous catalyst regeneration reforming 305
 – fluid catalytic cracking 145, 190, 240
 – HP hydrocracking 429
 liquid density 36, 43, 54
 liquid enthalpy 64
 liquid feeds 198
 liquid heat capacity 43, 53
 liquid petroleum gas (LPG)
 – continuous catalyst regeneration reforming 253, 257, 270, 291
 – fluid catalytic cracking 180, 187, 192, 199, 224, 230
 – HP hydrocracking 419 ff
 – MP hydrocracking 377, 407
 liquid phases 106
 liquid products 311, 409
 liquid streams 328
 liquid-phase reaction 388
 literature
 – continuous catalyst regeneration reforming 263
 – fluid catalytic cracking 153
 – unit-level models 269
 lognormal distributions 169
 lower heating value (LHV) 5
 LPS VAP 419 f
 lubricant production 117
 lump composition 162

lumped kinetics *see* kinetic lumping
 LVGO 117, 122

m

main fractionator *see* fractionator
 mass balance
 – atmospheric distillation unit 63
 – continuous catalyst regeneration reforming 280 ff
 – fluid catalytic cracking 227
 – hydrocracking 381
 mass flow
 – atmospheric distillation unit 58
 – oil fractions 34, 42 f
 – vacuum distillation unit 122
 mass vapor fraction 83
 mean average boiling point (MeABP) 50
 – hydrocracking 394, 402
 – fluid catalytic cracking 173
 – oil fractions 9, 18, 54
 mechanistic FCC models 154
 medium-pressure hydrocracking (MP HCR) 363, 366, 376, 383
 MESH equations 64
 metal coke 162 f
 metal functions 261, 266
 metal site reaction 372
 metalloporphyrin components 137
 metals content 198, 210 f, 214
 methane 147, 307
 methylcyclohexane (MCH) 300
 methylcyclopentane (MCP) 262, 300, 305
 mixed coefficient approach 43
 model applications
 – continuous catalyst regeneration reforming 293
 – fluid catalytic cracking 184, 233 ff
 – hydrocracking 456
 – HP hydrocracking 425–429
 – process optimization 95
 – production planning 190
 – refinery production planning 304
 – vacuum distillation unit 135
 model development
 – Aspen HYSYS 75
 – atmospheric distillation 63
 – continuous catalyst regeneration reforming 280, 309
 – fluid catalytic cracking 145–252
 – hydrocracking 378
 – vacuum distillation unit 124
 model prediction *see* prediction
 model results *see* results
 molar flow 105

- molar-average boiling point (MABP) 9
- molecular composition
 - continuous catalyst regeneration reforming 329
 - fluid catalytic cracking 145, 170
 - hydroprocessing units 365
- molecular weight 43, 54
 - CatReform model 273
 - continuous catalyst regeneration reforming 276
 - fluid catalytic cracking 173
 - hydrocracking 395
 - oil fractions 31 ff, 39
- molecular-type homologous series (MTHS) representation 370
- motor octane number (MON)
 - continuous catalyst regeneration reforming 268 ff, 272, 294 ff, 307 f, 350–357
 - delta-base vectors 308 f
 - fluid catalytic cracking 156 f, 175 f, 198, 212 f
 - HP hydrocracking 430
 - oil fractions 6 f
- moving-bed catalyst regeneration 255
- MS Excel spreadsheet *see also* Excel
 - gas streams 123
 - interface (ADU) 68
 - mass / hydrogen balance 281
- multiscenario delta-base vectors 431
- multistage operation modeling 63
- Murphree stage efficiency
 - atmospheric distillation unit 65
 - continuous catalyst regeneration reforming 274
 - fluid catalytic cracking 165
 - hydrocracking 398
- n**
- naphtha
 - atmospheric distillation unit 62, 66, 85, 99
 - continuous catalyst regeneration reforming 256
 - D-86 comparison curve 110 f
 - fluid catalytic cracking 170 f, 224, 230, 244
 - HP hydrocracking 419 ff, 427 f
 - hydrocracking 380, 400
 - MP hydrocracking 376, 407 ff
 - paraffin/aromatic content 51
- naphthabenzothiophene 369
- naphthenes 48
 - CatReform model 274
 - continuous catalyst regeneration reforming 259–264, 280–290, 351
 - fluid catalytic cracking 152 f, 155, 163, 170, 198
 - hydroprocessing units 369 ff
 - oil fractions 6
- networks
 - Aspen HYSYS Petroleum Refining HCR 371–376
 - calibration 174
 - continuous catalyst regeneration reforming 264 ff, 286
 - coke balance 163
 - heat-exchanger 61
 - kinetic lumping 30, 162, 253, 261–268, 363
 - reaction 270, 363, 366, 382
- nickel contaminants 137
- nitrogen 198, 211, 369 f
- nomenclature 53, 116, 248, 358, 475
- non-linear programming (NLP) 191
- o**
- objective functions 337, 385, 444–450
- octane 151, 254
- octane number *see also* research –, motor octane number
 - continuous catalyst regeneration reforming 293
 - oil fractions 6
- oil fractions 1–56, 103 f
- Oil Manager (Aspen HYSYS) 75 ff, 100 ff
- olefins 147, 151 f, 198
- on stage convention 63
- operating conditions
 - atmospheric distillation unit 67
 - continuous catalyst regeneration reforming 260, 285
 - fluid catalytic cracking 145, 158, 184, 191, 199, 214
 - hydrocracking 456
 - HP hydrocracking 425
 - hydrocracking 383
 - hydroprocessing units 365
 - vacuum distillation unit 125
- organic nitrogen compounds 372
- outlet streams 381
- outlet temperature
 - atmospheric distillation 61, 70
 - catalyst bed 403, 415
 - preheat train 82, 215
 - riser 84, 184, 199, 216, 233–240
 - T-100 473
 - vacuum distillation unit 118
- overall Aspen HYSYS model 177
- overall column (stage) efficiency 65, 165, 274, 399

- overall modeling strategy 174, 285
- overall reaction selectivity 164
- overcracking 187
- overflash 61, 82, 129, 135
- overhead gas compressor 145
- overhead vapor 149
- overhead wet gas system 230

- p**
- paraffin-naphtene-aromatic (PNA) content
 - 48 ff *see also* naphthene, aromatic
 - continuous catalyst regeneration reforming 253, 267, 276 ff
- paraffins
 - CatReform model 271, 274
 - continuous catalyst regeneration reforming 254–266, 280, 284, 290
 - fluid catalytic cracking 151–156, 163, 170
 - hydroprocessing units 369 ff
 - oil fractions 6
- pathway models 154
- Peng-Robinson equation of state (EOS)
 - atmospheric distillation unit 81, 92, 109
 - liquid density 36
 - oil fractions 23
 - vacuum distillation unit 126 f
- petroleum component list 201
- petroleum fractions 1, 51, 120 ff, 171
- petroleum gas 147
- petroleum oil 365
- physical properties
 - minimum properties for pseudocomponents 31, 39
 - oil fractions 1–56
 - refinery modeling 48
 - required properties for process modeling (simulation) 31
 - thermodynamic approaches 43
- PIMS *see* Aspen PIMS
- pinch technology 61
- pinning 271
- plant data
 - atmospheric distillation unit 58, 84, 91, 95, 115
 - continuous catalyst regeneration 253, 264, 280, 285, 291, 306, 329
 - fluid catalytic cracking 145, 158, 176, 225, 247
 - hydrocracking 440 ff
 - hydroprocessing 363, 369, 379, 383, 412, 422, 431, 440–455
 - Riazi-Daubert correlation 51
 - vacuum distillation units 117, 129
- platinum 260
- plug flow reactors (PFRs)
 - hydrocracking 388
 - continuous catalyst regeneration reforming 268
 - fluid catalytic cracking 159
- postconvergence 91
- pour point 4
- Poynting correction factor 44, 54
- predictive modeling
 - atmospheric distillation column 92
 - continuous catalyst regeneration reforming process 253–362
 - fluid catalytic cracking 145–252
 - hydroprocessing units 363–478
- prefractionation units 81
- preheat train 60, 81
- preheater 347
- pressure
 - atmospheric distillation unit 70
 - CatReform model 274
 - continuous catalyst regeneration reforming 257, 261
 - column 85
 - critical 34, 54
 - fluid catalytic cracking 175, 217, 231 ff
 - hydrocracking 380, 395
 - vacuum distillation unit 118 f, 125
- probability distribution 124
- process chemistry
 - continuous catalyst regeneration reforming 260
 - fluid catalytic cracking 151
 - continuous catalyst regeneration reforming 319
 - fluid catalytic cracking 198 ff
 - hydrocracking 441, 462
 - vacuum distillation unit 140
 - see also* plant data, process data, process description
 - atmospheric distillation 58
 - continuous catalyst regeneration reforming 255, 303, 309
 - fluid catalytic cracking 147, 196
 - MP hydrocracking 376
 - vacuum distillation unit 117
- process flow diagrams (PFD)
 - see also* flowcharts
 - fluid catalytic cracking 196
 - hydrocracking 472
 - hydroprocessing units 366
 - reorganization 104
 - vacuum distillation unit 118, 124
- process modeling
 - atmospheric distillation unit 57

- continuous catalyst regeneration reforming 253
 - fluid catalytic cracking 145
 - hydroprocessing (hydrocracking and hydrotreating) 363
 - vacuum distillation unit 117
 - process optimization
 - continuous catalyst regeneration reforming 293
 - fluid catalytic cracking 184, 231
 - hydrocracking 456
 - HP hydrocracking 425
 - model applications 95
 - VDU deep-cut operation 135
 - process thermodynamics
 - see* thermodynamics
 - process yields 253 *see also* product~, yields
 - product blending 191
 - product composition 310
 - see also* composition
 - product distribution
 - atmospheric distillation unit 74
 - continuous catalyst regeneration reforming 351
 - feed flow rate 427
 - product properties 175, 198
 - atmospheric distillation unit 58, 111
 - HP hydrocracking 422
 - hydrocracking 402
 - MP hydrocracking 412
 - vacuum distillation unit 125
 - product recovery specifications 86
 - product yields
 - atmospheric distillation column 92
 - fluid catalytic cracking 145, 166, 177, 237, 240
 - fluid catalytic cracking 219 ff
 - HP hydrocracking 419
 - hydrocracking 439 ff, 462
 - MP hydrocracking 407
 - vacuum distillation unit 132, 135 f
 - production planning 304
 - propane 147, 244, 291, 307
 - properties of refinery process 30
 - propylene 244
 - pseudocomponents 52
 - boiling-point ranges 8
 - fluid catalytic cracking 146
 - hydrocracking 393–399, 469 ff
 - oil fractions 26
 - vacuum distillation unit 120, 127
 - pumparounds
 - atmospheric distillation unit 74, 88, 92
 - hydrocracking 475
 - vacuum distillation unit 119, 132
 - purge gas 381
- q**
- quality
 - atmospheric distillation unit 74, 92
 - vacuum distillation unit 137
- r**
- Rackett parameter 37, 54
 - Raoult's law 43
 - rate-based approach
 - atmospheric distillation unit 63, 87
 - continuous catalyst regeneration reforming 264 ff
 - hydrocracking 390 f
 - reaction classes
 - CatReform model 270
 - continuous catalyst regeneration reforming 260 ff
 - fluid catalytic cracking 152
 - hydroprocessing units 372
 - reaction network *see also* network
 - Aspen HYSYS Petroleum Refining 373
 - hydrocracking 382
 - hydroprocessing units 363
 - reactor delta temperature 284
 - reactor performance
 - continuous catalyst regeneration reforming 335
 - HP hydrocracking 415 f
 - MP hydrocracking 403
 - reactor temperature *see also* temperatures
 - continuous catalyst regeneration reforming 304, 318, 322, 351
 - HP hydrocracking 425
 - hydrocracking 384, 437, 457
 - reactor–fractionator simulation 465
 - reactor-regenerator unit 147
 - reactors
 - continuous catalyst regeneration reforming 256, 311–318
 - fluid catalytic cracking 196
 - hydrocracking 383–392, 433, 441
 - hydroprocessing units 363 ff
 - oil fractions 30, 42
 - recalibration 287
 - reconstructed crude feed 102
 - recontactor 288, 346
 - Redlich–Kwong (RK) 46
 - refining *see also* Aspen HYSYS Petroleum Refining
 - process models 30
 - oil fractions 1 ff

- reactors palette 316
 - reflux ratio
 - continuous catalyst regeneration reforming 275
 - fluid catalytic cracking 167
 - hydrocracking 399
 - reformate splitter 275
 - reformer 352
 - reformer calibration 333
 - reformer components 313 ff
 - reforming, continuous catalyst regeneration 253–362
 - refractive index 51, 54
 - atmospheric distillation unit 66
 - CatReform model 274
 - fluid catalytic cracking 168, 173
 - hydroprocessing units 370
 - oil fractions 5
 - regenerators 159 ff, 199, 216, 222, 229
 - Reid vapor pressure (RVP) 77, 349
 - remained catalyst life 425
 - remixing section 287, 345
 - rescaling spreadsheet 330
 - research octane number (RON)
 - continuous catalyst regeneration reforming 268 ff, 294 ff, 307 f, 350–357
 - delta-base vectors 308 f
 - fluid catalytic cracking 156 f, 175 f, 198, 212 f
 - HP hydrocracking 430
 - oil fractions 6 f
 - residence time 388
 - residual Hessian parameters 217, 228
 - residue feed 190, 211
 - residue oil 419 ff
 - residue paraffin 163
 - results
 - atmospheric distillation column 91, 109
 - continuous catalyst regeneration reforming 287, 326
 - fluid catalytic cracking 176, 219, 236 ff
 - HP hydrocracking 415
 - MP hydrocracking 403
 - vacuum distillation unit 143 f
 - rhenium 260
 - Riazi-Daubert correlation 51 f
 - CatReform model 274
 - fluid catalytic cracking 170, 173
 - hydrocracking 395 ff
 - oil fractions 41
 - rigorous model
 - continuous catalyst regeneration reforming 306
 - delta-base vectors 195
 - fluid catalytic cracking 146
 - vacuum distillation unit 124, 128, 132
 - ring closure/expansion
 - CatReform model 271
 - continuous catalyst regeneration reforming 266, 284, 341
 - ring dealkylation 372
 - riser 158–161, 199, 215–229
 - riser outlet temperature (ROT) 84, 184, 199, 216, 233–240
 - riser-regenerator complex 145 ff
 - running initial model 324
- S**
- salt removal process *see* desalting
 - schematics
 - catalyst regeneration process 258
 - continuous catalyst regeneration reforming 309
 - downstream fractionation 149
 - fluid catalytic cracking 147
 - sediments 58
 - selectivity 164, 174, 260
 - semiregenerative processes 255
 - sensitivity 384
 - separators
 - continuous catalyst regeneration reforming 258
 - hydrocracking 380
 - hydroprocessing units 369
 - MP hydrocracking 376
 - oil fractions 30
 - vacuum distillation unit 128
 - side strippers 66–92
 - side-chain scission 152
 - simple thermodynamics *see* thermodynamics
 - simplified model *see* model
 - simulations
 - atmospheric distillation unit 73
 - continuous catalyst regeneration reforming 306
 - delta-base vectors 195 *see also* models
 - fluid catalytic cracking 146, 159
 - hydrocracking 382
 - oil fractions 29
 - vacuum distillation unit 124, 128, 132
 - single-stage hydrocracking 364, 399
 - slip factor 161
 - smoke point 4
 - Soave-Redlich-Kwong (SRK) 46, 81
 - solid removals 59
 - solubility 53
 - solver parameters
 - atmospheric distillation unit 84, 104

- continuous catalyst regeneration reforming 321 ff, 342
 - fluid catalytic cracking 169 f, 214 ff
 - sour gas 224, 407
 - space velocity 389
 - specific gravity 50, 54
 - see also* API gravity
 - atmospheric distillation column 95
 - beta function data fitting 69
 - CatReform model 274
 - continuous catalyst regeneration reforming 257 ff, 276
 - fluid catalytic cracking 170, 192 ff, 198, 211, 242
 - HP hydrocracking 422
 - hydrocracking 394, 402
 - MP hydrocracking 413 f
 - oil fractions 4, 15, 39
 - vacuum distillation unit 122
 - specifications
 - atmospheric distillation unit 73 ff
 - continuous catalyst regeneration reforming 275, 347
 - fluid catalytic cracking 167
 - main fractionator 231
 - rigorous VDU model 132
 - T-100 473
 - Spencer-Danner method 37
 - splitter 275, 369
 - sponge oil absorber 145, 230
 - spreadsheet
 - atmospheric distillation column 113
 - continuous catalyst regeneration reforming 330
 - distillation curves 7
 - gas streams 123
 - HCR mass balance 382
 - MeABP calculation 11
 - square cut yields 219 ff
 - stabilization 149
 - stage efficiency
 - atmospheric distillation unit 65, 84
 - fluid catalytic cracking 165
 - hydrocracking 398
 - stage temperatures 92
 - stage-by-stage models 165
 - start of run (SOC) 425
 - steam rates
 - atmospheric distillation column 91
 - fluid catalytic cracking 199, 215
 - vacuum distillation unit 127, 135 f, 141
 - steam stripped side columns 66
 - stream composition 468
 - stream correlations 90
 - stream specifications 347
 - strippers
 - fluid catalytic cracking 145, 150, 159 ff, 167, 184, 230
 - hydrocracking 399, 475
 - MP hydrocracking 376, 405
 - stripping steam *see* steam
 - structure-oriented lumping (SOL)
 - fluid catalytic cracking 154
 - hydroprocessing units 366, 379
 - sulfides 369
 - sulfur content
 - fluid catalytic cracking 175, 193 ff, 198, 211, 242
 - gasoline 189
 - hydrocracking 384
 - hydroprocessing units 365, 369 f
 - oil fractions 4
 - superficial gas velocity 161
- t**
- temperature 49 *see also* weight-average ~, reactor ~, stage ~, riser ~, outlet ~
 - atmospheric distillation unit 61, 70, 85, 91, 109
 - CatReform model 274
 - continuous catalyst regeneration reforming 253–261, 274, 284–291, 304, 322
 - critical 34
 - fluid catalytic cracking 151, 167, 175, 182 ff, 199, 231 ff
 - HP hydrocracking 415 ff
 - hydrocracking 380, 383, 395
 - hydroprocessing units 365
 - MP hydrocracking 405
 - oil fractions 40
 - vacuum distillation unit 118, 125–141 f
 - temperature–process yield relation 293
 - ten-lump model 154
 - tetrahydrobenzothiophenes 369
 - thermal cracking
 - fluid catalytic cracking 151
 - vacuum distillation unit 137
 - thermodynamic approaches, required physical properties and recommendations 43
 - thermodynamics 40–45
 - atmospheric distillation unit 63, 78, 81
 - continuous catalyst regeneration reforming 312
 - fluid catalytic cracking 204 ff
 - oil fractions 1–56
 - vacuum distillation unit 126
 - thermophysical properties
 - CatReform model 273

- crude oil/petroleum fractions 52
- oil fractions 1
- thiophene 369
- three-layer onion hydroprocessing units
 - modeling 366
- time-on-stream catalyst deactivation 163
- toluene 253, 284, 290, 300
- true boiling point (TBP) 71
 - atmospheric distillation 75, 91
 - continuous catalyst regeneration reforming 276
 - distillation curve 52
 - fluid catalytic cracking 160, 168, 173, 226
 - hydrocracking 393–397
 - oil fractions 5, 8 ff
- true crude assays 90
- twenty-one-lump kinetic model 162
- two-lump scheme 390
- Twu correlation 32, 52

- u**
- unit throughput, FCC 187
- unit-level models 153, 158, 267
- UOP design, FCC 147
- utility energy consumption 303

- v**
- vacuum distillation unit (VDU) 7, 117–144
- vacuum gas oil (VGO)
 - fluid catalytic cracking 147, 170 f, 189, 216
 - hydrocracking 376, 383
 - hydroprocessing units 364, 371
 - vacuum distillation unit 118, 122, 132
 - paraffin/aromatic content 51
- vacuum residue 189
- validation
 - atmospheric distillation unit 92
 - CCR reforming model 285 ff
 - fluid catalytic cracking 177 ff, 227
 - hydrocracking 379
- valves 159
- vanadium contaminants 137
- vapor enthalpy 64
- vapor pressure 31–45
- vapor product rate 112
- vaporization 43 ff
 - atmospheric distillation unit 60 f
 - continuous catalyst regeneration reforming 277
 - oil fractions 31, 40, 53
 - vacuum distillation unit 118, 135
- vapor-liquid crude mixture 60
- vapor-liquid equilibrium (VLE)
 - distillation columns 8
 - hydrocracking 396 ff
 - oil fractions 42
- vapor-liquid interface 63
- vapor-liquid phases 31
- vapor-liquid separation 135
- Variable Navigator 233, 352
- viscosity 51
 - atmospheric distillation unit 66
 - fluid catalytic cracking 168
 - hydroprocessing units 370
 - oil fractions 32
- viscosity gravity constant (VGC) 170, 173
- volatility
 - fluid catalytic cracking 177
 - hydrocracking 393
 - oil fractions 7

- w**
- wash grid 118, 128, 137
- water draw stream 106 f
- water wash 127, 150
- Watson factor 50 ff
 - atmospheric distillation column 116
 - fluid catalytic cracking 173
 - hydrocracking 394, 432
 - oil fractions 9, 31, 38 f, 53
- weight averaged inlet temperature (WAIT) 262, 293 ff, 301, 322, 351
- weight-average reactor temperatures (WART)
 - feed flow rate/product distribution 427
 - hydrocracking 456
 - HP hydrocracking 415 f
 - MP hydrocracking 403
- weight-averaged bed temperature (WABT) 271
- weighted hourly space velocity (WHSV) 271, 296
- weighting factors 284, 338
- wet gas compressor 150
- what-if scenario 293
- workflow *see also* flowchart, schematics
 - HCR modeling 378
- workshops, hand-on
 - applications of HCR model to process optimization 456
 - basic FCC model 204
 - build atmospheric distillation model using back-blending procedure 98
 - build CCR model in Aspen HYSYS Petroleum Refining 309
 - build preliminary reactor model for HCR process 433
 - build downstream fractionation model for CCR 344

- calibrating basic FCC model 222
 - calibrating CCR model 332
 - calibrating preliminary HCR reactor model to match plant data 440
 - calculate mean-average boiling point of a given assay 18
 - case study to vary RON and product distribution profile 351
 - connect HCR reactor model to fractionator simulation 465
 - deep-cut operation of a vacuum distillation unit 139
 - duplicate oil fractions in Aspen HYSYS Petroleum Refining 21
 - extrapolate incomplete distillation curve 15
 - FCC main fractionator and gas plant system 230
 - FCC case study to identify different production scenarios 233
 - FCC generation of delta-base vectors for LP-based production planning
 - interconvert distillation curves 13
 - investigate changes in ADU product profiles with new product demands 111
- x**
- xylenes 253, 272, 284, 290, 300
- y**
- yields *see also* product yields
 - atmospheric distillation column 92, 97
 - back-blending 99
 - continuous catalyst regeneration reforming 285 ff, 298, 304–312, 327, 351
 - fluid catalytic cracking 151 ff, 192 ff, 219, 185
 - hydrocracking 385, 427, 439 ff
 - vacuum distillation unit 132, 135 f